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RETYPED COPY.

January 21, 1982

403126

Mr. Jonathan Weisgall
Ginsburg, Feldman, Weil and Bress
1700 Pennsylvania Avenue, N.W.
Washington, D.C. 20006

Re: Bikini Resettlement

Dear Jonathan:

It was indeed a pleasure to meet with you recently so that we could have the opportunity to discuss the outgoing problems in the Marshalls, and in particular Bikini. I too feel strongly about the need for independent scientists to assess the radiological and radiobiological data from Bikini, it is the least we can provide these unfortunate people who have suffered for many decades.

As per your request, I will be most happy to expand upon the issues raised in our conversation. For clarification purposes, I will include the questions contained in your letter of January 7, 1982, which will be followed by my responses.

"1. Misstatements and errors in the 1980 DOE booklet ('The Morning of Radiation at Bikini Atoll') that you feel require correction by the Bikinians" independent scientists."

Response. This DOE booklet, like the companion booklet for Enewetak, is replete with deceptive and misleading language, all of which tends to downplay and underestimate the potential health risks associated with exposure to low-level radiation. The following statements are representative of those misleading distortions:

Page 2: "thyroid - A small part of the body located in the throat (page 17)"
The authors should have pointed out that the thyroid is essential for development and body metabolism, and that its injury led to the many cases of dwarfism and hypothyroidism in the Rongelap and Utirik populations. Also, the authors neglected to mention that thyroid disease in the exposed populations has a long latency period lasting many decades.

Page 2: "plutonium - A kind of radioactive atom, and an energy called 'alpha radiation' comes from it. Plutonium will not disappear for hundreds and hundreds of years."
The authors should have been more honest in pointing out that plutonium has a half-life of 24,000 years.

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Page 2: "standard (radiation standard) - The amounts of radiation that have been established that people should not exceed." To an unsuspecting Marshallese, this statement implies a threshold level of radiation injury. The authors should have pointed out that no radiation level is safe, as in the linear model, and moreover, that there is growing evidence for a super-linear model which states that cancer may be induced at lower levels of radiation exposure due to the numbers of cells that may be spared for a later malignancy.

Page 2: "radiation - A kind of energy that comes from radioactive atoms as they change and become other kinds of atoms. This energy we cannot see, hear, smell, taste, or feel." Nowhere does it state that radiation is harmful to human health.

Page 4: "Of the atoms that are radioactive, some have always been a part of the world. These are God-made and it will take a very long time before they go away." To invoke the name of God with the Marshallese, who are very Christian, especially as it relates to radiation, is a cheap shot which takes advantage of the peoples' religious beliefs. This statement violates the rule of logic insofar as it appeals to a higher authority--one almost gets the distinct impression that God sanctions radioactivity because it was present at the Creation. This entire page distorts the fact that unlike other locations in the world, Bikini is the site of 23 nuclear explosions--with many of these in the megaton range. I do not know of a single honest radiation scientist who would return the Bikini to raise a family, yet the language contained on page 4 gives the impression that the radiation at Bikini is not very different from other locations in the world.

Page 12: "No alpha radiation is able to reach people's bodies from the radioactive atoms in the soil." This statement is false. Plutonium, an alpha-emitter, can enter the foodchain and be internally absorbed into a human body. Also, it takes only one-millionth of a gram of inhaled plutonium dust to cause a lung cancer. It would be like playing radiation roulette to see how long it would take for the returning Bikinians to contract lung cancer after living at their former atoll.

Page 14: "Some of the strontium atoms will leave the body when people eliminate, but many of the strontium atoms will remain in the bones, and radiation will continue to come from these radioactive atoms." The authors failed to mention that whenever radioisotopes are ingested in the human body, they come into contact with normal, healthy cells. When this happens, the nuclei of normal cells are bombarded with radioactive particles and high- and low-energy rays which can alter healthy cells. The result of this nuclei bombardment can lead to cancer, and

while living in a radioactive environment where there are known "hot-spots," as well as foodchain contamination, the Bikinians run a high risk of contracting many forms of cancer over the years. Also, because the reproductive organs will be exposed to low-level radiation, it is possible that genes will also be affected, which may result in increased genetic problems. It is not unlikely that the entire gene pool of the Bikinians may someday manifest in unprecedented birthdefects, and the Bikinians should be warned about this possible fate.

Page 15: "Some radioactive atoms stay in the lungs for a long time." The authors might have mentioned that radioactive atoms which stay in the lung for a long time may cause lung cancer.

Page 17: "Therefore, there are people of Bikini and people of other places around the world who will get diseases of cancer that are not produced by radiation."
This is a ludicrous and dangerously deceptive statement as it applies to people who may reinhabit a former nuclear test site where they will be constantly exposed to low-level radiation. This passage is typical of how the DOE booklet downplays the health risks associated with radiation exposure.

Page 17: "If the diseases of cancer appear among the people of Bikini who have received radiation or who may receive radiation in the future, they would be no different from those that appear in other people around the world."
The absurdity of this misleading statement barely requires amplification. I wonder if the authors of this DOE booklet would offer those ridiculous statements to their own family members if they were considering the resettlement of Bikini?

Page 17: "When cancer occurs in a person, no one is able to know if the cancer came from radiation or from other things."
The authors know better than this: Using biostatistical methods, radiation scientists are able to find statistically significant incidence rates of radiation-induced carcinoma, as in the Japanese bomb victims, the Rongelap and Utirik populations, and the persons treated in childhood with X-rays for thymic enlargement.

Page 17: "Scientists know that it is more likely that harm (cancer) will occur to a person who receives a large amount of radiation then to one who receives a small amount of radiation."
It is hard to imagine that the authors of the DOE booklet did not read the 1977 Brookhaven report by Dr. Robert A Conard entitled 'Summary of Thyroid Findings in Marshallese 22 Years After Exposure to Radioactive Fallout.' On page nine of this report, Conard himself refutes the above statement where he says, "One can postulate that the thyroid doses in the Rongelap children (700-1400 rads) were high enough to cause many cells to die at mitosis because of lethal damage

to the reproductive mechanism and thus to reduce the number of cells at risk for malignant transformation. At lower doses, as in the adult group, a greater number of cells would be spared for malignant transformation. The authoris are obviously attempting to obsecure the fact that low-level radiation may indeed be more dangerous at Bikini than the islanders might consider otherwise, and it is skin to a criminal act to hide this information from unsuspecting and unknowledgeable people.

Page 18: "If people will again return to live on Bikini Atoll in the future, scientists can again use this instrument (whole body counter) to measure the amount of gamma radiation from radioactive atoms in people's bodies as a result of their living on the atoll."
This is tantamount to admitting that the scientists know in advance that the Bikinians will be ingesting gamma-emitters at Bikini, such as cesium-137 and cobalt-60.

Page 19: "The U.S. Government and many other governments approve and follow these recommendations."
The authors, in mentioning the radiation standards of the ICRP, UNSCEAR, IAEA, and the EPA, neglected to mention that these radiation standards, far from being unanimously accepted, are probably the most controversial aspect of present-day radiation physics. The Bikinians have a right to know that there are many radiation scientists who feel that these radiation standards are extremely lax and that they grossly underestimate the potential hazards associated with radiation exposure. When one roads through this booklet, one gets the definite impression that there is universal consensus about radiation standards. Moreover, the Bikinians have a right to know that researchers such as Gofman, Mancuso, Carl Johnson, et al. have had their Government-funded studies terminated because their findings suggested that the accepted radiation standards underestimated the health risks of radiation exposure.

Page 21-27: The scenarios and accompanying risk estimates on these pages are conservative calculations, i.e., "best-cases" verses "worst-cases." The Bikinians have a right to know this, especially in light of the history of repeated mistakes by Brookhaven, the DOE, Interior, et al. in the Marshalls. Specifically, the fact that the "unexposed" Rongelapese who returned with the "exposed" islanders in 1957 after Bravo became exposed to residual radiation should be relevant here. In this connection, the Japanese scientists who came to the Marshalls in 1973 reported that the Rongelapese should not have returned in 1957 must be mentioned. Also, the lesson or the catastrophic Bikini return in the 1970s should not be ignored.

As an addendum, the authors of the DOE booklet have failed to mention the psychological impact of the weapons tests in

the Marshalls. My doctoral discertation specifically addresses this issue, and for the past seven years I have been gathering data about the social and cultural effects associated with the weapons tests. I am distressed by the fact that the Brookhaven researchers have continually ignored the psychological impact of the weapons tests, and I consider the psychological problems to be as important as the actual radiation-induced pathologies in terms of how the weapons tests have disrupted Marshallese culture. For example, when I was in the Marshalls last year, I spoke with Jabwe Jojur who is the magistrate of Rongelap. Jabwe explained that since 1970, when the DOE and DOD made the radiological survey of the Northern Marshalls, that DOE declared the northern half of Rongelap off-limits due to dangerous levels of residual radiation. Jabwe told me of the fears his people have of living at Rongelap, and related that the people know that fish in the lagoon circulate throughout the entire lagoon. Jabwe explained that the people have much fear and anxiety about remaining on Rongelap--where one-half of their atoll is off-limits--and many people are considering abandoning the atoll altogether.

At Enewetak, where many of the islanders have recently returned after the cleanup and rehabilitation program, it is too early to assess the full impact of the possible psychological stress and anxiety which may manifest there.

In my research at Utirik, I found an alarming degree of fear and anxiety among the islanders, especially since between five and six new cases of thyroid disease are diagnosed each year as a late-effect of the fallout from Bravo. The Utirik people believe that they are living in a still-contaminated environment, and worse, they feel that things are getting more serious over time. Indeed, the fact that five or six people must have thyroid surgery every year and be put on a daily medication of thyroid replacement bears out their worst fears and suspicions about their situation. Needless to say, the people now attribute just about every illness and malady to their radiation exposure, and it is safe to say that on top of the radiation-induced injuries, the people now suffer from hypochondria. When I try to point this out to the Brookhaven medical researchers, they continually laugh with scorn at the islanders and think it is silly that they should have these fears. As a social scientist, I submit that the people's fears and anxieties are a medical disorder directly related to the actual radiation-induced pathologies.

If the Bikini people return to their former atoll, it is my belief that they too will suffer from the knowledge that their environment is still radioactive and that it contains "poison"--the Marshallese equivalent for radiation. Additionally their resettlement failure a few years ago will loom ominously in the background to remind them that the scientists can make mistakes.

"2. A detailed explanation of the Rongelap verses Utirik exposure levels and resulting thyroid problems. Your articles state that a much higher rate of thyroid problems have developed among the Utirik group, which received only 1/10th of the radiation of the Rongelap group, but I do not see precise numbers in the documents you gave me."

Response: At the moment, I have yet to see Dr. Conard's 26-Year Annual Medical Report from Brookhaven, which is expected to be completed at any time. I therefore will restrict my figures to the material contained in the 1980 AAAS symposium (which I enclosed previously) by Dr. Hugh Pratt--these are the latest numbers I have seen regarding incidence rates of thyroid neoplasia in the Marshallese. Dr. Pratt states that in the Rongelap group ("exposed-and "unexposed," i.e., those on Rongelap during the Bravo fallout and those who returned in 1957) there were 66 thyroid tumors with 7 of these being malignancies. Pratt says at Utirik there were 16 thyroid tumors and 3 of these were malignancies. If these figures are adjusted, 7 out of 66 tumors at Rongelap are malignancies, whereas 12 out of 64 tumors at Utirik are malignancies. That is, there are nearly twice as many thyroid cancers at Utirik than at Rongelap. The Conard 20-Year Report may show an even higher ratio of thyroid cancer for the Utirik people. In connection with the above, a former physician with the Brookhaven medical team--Dr. Konrad Kotrady of the University of Utah School of Medicine--found the same phenomenon. In his 1977 report "The Brookhaven Medical Program to Detect Radiation Effects in Marshallese People," Kotrady made the following statement: "...the ratio of thyroid cancer to thyroid modules found in exposed people at both islands is higher at Utirik than at Rongelap." (Page 8 of enclosed Kotrady report)

As indicated earlier, Conard himself explains that at higher doses of radiation many cells would die at mitosis because "of lethal damage to the reproductive mechanism and thus reducing the number of cells at risk for malignant transformation. At lower doses, as in the adult (Rongelap) group, a greater number of cells would be spared for malignant transformation." (Page 9, "Summary of Thyroid Findings in Marshallese 22 Years After Exposure to Radioactive Fallout," by Robert A. Conard.)

Karl Z. Morgan, in his 1978 paper titled "Cancer and low level ionizing radiation," (In Bulletin of the Atomic Scientists, September, 1978, pp. 30-41) suggests that low level radiation may cause more cancer than previously believed. He supports this view with the same logic as that of Conard in the study previously mentioned, specifically with regard to the cell-killing effect at higher doses.

I might mention that I am deeply troubled about the Government's tendency to minimize health risks associated with radiation exposure. For example, in the 1980 BEIR Committee Report, it is stated in the chapter on the thyroid gland (page 304) that "A minimal latent period of 10 years seems to be reasonable" (which follows the 9-year latency period in the Rongelap group) and "A peak incidence perhaps 20 years after exposure is suggested by some studies." This last part troubles me, especially since the BEIR committee specifically refers to Conard's

22-Year Summary of Thyroid Findings, where Conard states: "The moan latent period for radiation-induced thyroid tumors may be as long as 30 years (page 9, emphasis added)."

Following this point, a noted thyroid cancer researcher posited an even longer period for the induction of thyroid cancer. In a 1978 paper titled "Etiology of Thyroid Cancer" (in Thyroid Cancer by Larry Greenfield, CRC Press, Florida, 1978), Louis Nompoleann (et al.) postulated that the moan latency period of thyroid cancer may be as long as 40 years (page 47, emphasis added).

"3. Different effects of radiation depending on age."

Response: I refer you again to the 1980 AAAS symposium, where J. E. Rall of the National Institutes of Health addresses this question in reference to the Marshallese. In discussing the thyroid uptake of the radioiodines in the exposed populations, Rall says:

> "Another peculiar and interesting property is that the uptake of iodine by the thyroid is generally about the same in children as it is in adults. That is, the fraction of iodine ingested which goes to the thyroid is about the same in a child as it is in an adult. But a child of a year has a thyroid which weighs one gram, and an adult thyroid weighs about twenty grams, so if you put the same amount of material in one gram you get twenty times as much radiation. So children get substantially higher doses." (AAAS symposium, page 18, emphasis added).

In addition to the above, it should be noted that if the Bikians are returned to their home atoll, children will be at a much higher risk for possible cancer induction because they--by definition--will have a longer residence period on the atoll in which to contract a possible malignancy.

"4. Fish at Bikini. My notes state that you were told by a University of Hawaii graduate student who accompanied DOE missions to the Marshalls that there are between 800 and 1,000 different species of fish at Bikini. Are all of these species highly migratory or are there special problems at Bikini related to consumption of fish there? Are these species found only at Bikini? Where is the underlying data?"

Response: During the June 1975 DOE survey to Utirik, I met a doctoral student from the University of Hawaii who was doing research with the Department of Oceanography. He told me that he was studying reef fish niche in Pacific atolls, and I remember my amazement when he told me there were "between 800 and 1,000 different species of reef fish at a typical atoll in the Marshalls." This student--whose name I unfortunately cannot remember--told me that most of the reef fish (as their name implies) were sedentary and usually did not venture out into the open ocean. As opposed to the migratory fishes,

such as tuna and mackerel, the roof fish inhabit specific niches in the atoll's lagoon, and the student was studying the interplay between fish niche and fish community in Pacific atolls.

There are two studies of fish population at Bikini, both of which are relevant here. Those studies by Leonard P. Schultz are titled "The Biology of Bikini Atoll With Special Reference to the Fishes" (Smithsonian Institution Annual Reports for 1947: 301-16, Washington, D.C., GPO, 1948) and "Fishes of the Marshall and Mariana Islands" (U.S. National Museum Bulletin 202, Washington, D.C., 1953). In the 1953 study, Schultz states that "In the biological cycling of materials there is not only an abundance of organisms but also a wide variety of species--some 700 among the fishes alone--so that whatever is not utilized by one is quickly taken by another." (Quoted from Jack Tobin's doctoral dissertation, "The Resettlement of the Enewetak People: A Study of a Displaced Community in the Marshall Islands," 1967, University of California at Berkeley, page 54.)

While on Utirik between the years 1975 and 1977, I recall that the islanders regularly ate between 30 and 40 different species of roof fish. Many of these fish--like the parrotfish--subsist by eating coral, and it is my guess that certain radionuclides (e.g., strontium-90) probably got recycled in the man-environment foodchain complex. If this hypothesis is correct, the Marshallese are in trouble: no less than one-third of all the fish I ate for two years on Utirik were parrotfish, and many of the others were likewise coral-eaters.

In this regard, I direct you to a study of ocosystem contamination at Bikini and Enewetak by researchers from the fish laboratory at the University of Washington at Seattle. This study is titled: "Polonium-210 and plutonium-239, plutonium-240 in the biological and water samples from the Bikini and Enewetak atolls," and appears in Nature, volume 255, May 22, 1975, pp. 321-23. It is rather curious why the researchers of this study--who were funded by the DOE--restricted their analysis to only the aforementioned isotopes, while they completely ignored cesium-137, strontium-90, cobalt-60, americium-241, etc. The authors did mention, however, that "The overall result indicates that inside the lagoon the radioactivity values of plutonium were more variable than those of polonium-210 (page 323, emphasis added)." This statement leads me to suspect that we are still shooting in the dark when we discuss possible radionuclide uptake for the people of Bikini, should they decide to return home.

"5. Restrictions on access to Bikini and compliance with prescribed diet. Your experiences in the Marshall Islands would be useful in this regard."

Response: While in the Marshalls early last year as a consultant for the Marshall Islands Litigation Project, I interviewed several people from Utirik who recounted their experiences after their evacuation following the 1954 "Bravo" hydrogen test. Most of the people from Utirik told me how they were instructed not to eat the local foods from Utirik when they returned home after their three-month evacuation to Kwajalein. The following excerpt from an

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interview with Nine Letobo is typical of the responses I elicited about the post-evacuation period at Utirik:

> "After our return from Kwajalein three months later (in June, 1954) things began to change. We resumed eating our own foods--some did this secretly at first--after we ran out of the food and pontoon water the AEC gave us, and some people even ate our own foods during the time we still had canned food and water." (Interview with Nine Letobo, aged 63, on Utirik Atoll, March 2, 1981)

More recently, I spoke with John DeYoung--an anthropologist by training--who has worked for many years on the problems in the Marshalls through the Territorial Affairs Office of the Interior Department, where he is employed. When I asked DeYoung about the feasibility of the proposed dietary restrictions for the returning Enewetak islanders, he said, "It is unrealistic to expect artificial living conditions, i.e., the restricted diet and living patterns, to be adhered to for 30 years." A more expansive version of my conversation with DeYoung appears in my article "A Tale of Two Islands: Bikini and Enewetak," in The Ecologist, volume 11, number 5, September/October, 1981, pp. 222-27.

In my estimation, I think it is fanciful to expect the people of Bikini--who have already violated their previous past with the Interior Department during their aborted relocation--to restrict their intake of locally grown feeds at Bikini Atoll. I am not convinced that the people truly understand--and this is the key--the long-term effects associated with living in a mildly radioactive environment. There is nothing in the Marshallese experience or cultural configuration which relates to an action in the present and a consequence 20, 30 or 40 years hence.

"6. DOE model diet. As I explained to you when we met, the diet used in DOE's 1978 survey assumed a daily intake of coconuts of approximately 300 grams, which amounts to a little over one coconut. This diet was connected by Micronosian Legal Services Corporation, and I suspect that they have purposefully chosen a low number. Do you know of other diet studies in the Marshalls?"

Response: I have not yet seen the data for dietary patterns which formed the basis for Micronesian Legal Service's Enewetak dose assessment, nor have I seen Jan Naidu's material on the Marshallese diet which he collected for Brookhaven National Laboratory. The following comments will be based therefore on Nancy Polleck's 1970 doctoral dissertation titled: "Breadfruit and Breadwinning on Namu Atoll, Marshall Islands," as well as my own information. As an agricultural and cooperative advisor on Utirik for two years, I became quite familiar with the Marshallese diet--especially the role of coconuts in the diet--insofar as my role as an agricultural

(cont'd.)

advisor pertained specifically to the production of copra meat from coconuts.

In her discussion of the role of coconuts in the Marshallese diet, Pollock is correct in stating that "The coconut cannot be classified as a staple food but as a most important additive to the diet (page 181)." She goes on to mention that an average of one coconut per person is consumed daily in the form of a beverage, and is here referring to the green coconut (page 181). Pollock then describes the Marshallese method of using shredded (or grated) coconut meat as an additive for other dishes--usually mixed in with rice to make a porridge or merely to sweeten the rice. She states that an average of between "3 and 15 nuts per meal are grated" for each household (page 182). According to my consus figures for Utirik, a household contains an average of ten persons. Also, it should be noted that this rice dish with grated coconut is consumed with at least two meals per day per person. If we take the average number of coconuts used for each meal--between 3 and 15 coconuts--we arrive at nine coconuts. Nine coconuts are therefore consumed by ten persons at least twice a day, which yields 1.8 coconuts per person per day (9 coconuts x 10 persons equals 0.9 coconuts, which when multiplied by 2 meals per person per day equals 1.8 coconuts).

Another food from the coconut is the "iu," or the embryo of a mature nut which has sprouted small leaves and has a tap root. These coconut seedlings will become new coconut trees if left alone, and are keenly sought out by Marshallese--especially children--as an ideal and tasty food. It was my experience that while in the coconut groves preparing copra, people would send their children out to round up many of these "iu" coconuts to eat while cutting copra. Also, a sweet porridge is made from the "iu."

The sap, or "jokaro," from the coconut tree is a highly prized beverage in the Marshallese diet. This is the fresh sap of the coconut collected by placing a bottle under the freshly cut end of the coconut spathe (Pollock, page 324). Several bottles (usually emptied 16-ounce soy sauce bottles) are collected at both dawn and dusk per household, and the "jokaro" is considered a nutritious beverage and is consumed by all members of the household.

"Jekamai" is a household syrup made from boiled "jokaro." This sweet syrup is used as a sweetener for beverages such as tea and coffee, and is loved by the Marshallese.

A Marshallese candy, called "amotoum," is prepared by grating many coconuts into the boiled sap ("jokamai") and then boiling this mixture over a fire for a period of time. The result is a molasses-like concoction which is then rolled into small balls and eaten as candy.

These are some of the ways in which coconuts enter the Marshallese foodchain, and it is an error to think that Marshallese merely consume coconuts--as we do when we purchase them from the store--by eating them directly from the husk. In the following paragraph, I will itemize my estimates of coconut consumption in the Marshallese diet, and it should be readily understood that such variables as the ratio of imported versus local foods, relative quantities consumed per individual, frequency of field ship service with food shipments, etc., should be kept in mind. The following estimates of coconut intake

(cont'd.)

are based upon the 236-gram per coconut figure given in Bowes and C.P. Church's Food Values of Portions Commonly Used (Lippincott, New York and Philadelphia: 12th edition, 1975, page 107), which is an authoritative nutritional text.

Estimated Marshallese Daily Diet

	Item	Estimated No. Grams
1	green drinking coconut (this is Pollock's figure--my estimate would be 2 drinking coconuts per person per day)	236 g.
1.8	grated coconuts used in rice and rice porridge (using Pollock's estimate of between 3-15 nuts per household per meal. I calculate the mean of 9 nuts per 10 persons to be 0.9 nuts x 2 meals, or 1.8 coconuts per person per day)	425 g. (1.8 x 236 g.)
0.5	"iu" from coconut embryo	118 g. (0.5 x 236 g.)
10	ounces of "jokaro" (this is my approximation)	280 g. (10 x 28 g.)
2	ounces of "jokamai" (my approximation)	56 g. (2 x 28 g.)
	Total average daily grams of consumed coconut	1,115 g.

As may be readily seen from my analysis of the estimated Marshallese daily diet, the figure of 1,115 grams of coconut per person is more than three times the estimate provided by Micronesian Legal Services. I am rather curious how they arrived at their 300-gram per capita rate. After having lived with Marshallese on Utirik for two years and subsisting on a Marshallese diet, this dietary estimate is as close as I can come to an approximation of the daily

(cont'd.)

coconut intake by the outer island Marshallese.

As a final comment, I would like to suggest the names of some interested radiation scientists whom you may wish to contact in relation to additional independent assessments of Bikini:

Karl Z. Morgan, health physicist, Georgia Institute of Technology

Joseph Wagoner, epidomiologist, Springfield, VA (202) 523-7144

Carl Johnson, opidomiologist, Rocky Flats, Colorado (303) 232-2328

F. Raymon Fosberg, botanist, Smithsonian Institution, (202) 381-5559

(Fosberg, the long-term editor of the Atoll Research Bulletin, accompanied Conard and the Brookhaven team during their 1957 annual Marshalls survey after the "Bravo" test. When he noticed abnormal vegetation patterns as he flew over Rongolap Atoll- and which he later confirmed in a field study--he speculated that these were caused by the fallout from "Bravo." When he tried to publish his findings, Conard attempted to suppress his article on radiation-damaged plants in the Marshalls. After having his article rejected by Science, Fosberg had it published in Nature in 1959. He maintains that Conard tried to cover up information about the fallout damage from "Bravo." Fosberg says he would like to be included in an independent survey of radiation damage in the Marshalls.

If I can be of further help to you with regard to your Bikinian clients, please feel free to contact me at any time.

Sincerely,

Glenn H. Alcalay
Department of Anthropology

Enclosure: Kotrady 1977 report (xerox)

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THE RADIATION-INDUCED RISK OF RESETTLING BIKINI ATOLL

BY

HENRY I. KOHN AND NANCY A. DREYER

with an appendix by

JOHN H. HARLEY

EPIDEMIOLOGY RESOURCES, INC.

P.O. BOX 57

CHESTNUT HILL, MA 02167

November 7, 1981 -- May 28, 1982

PREPARED FOR THE DEPARTMENT OF ENERGY

UNDER CONTRACT NO. DE-AC01-82EP12040

ABSTRACT

The Department of Energy (DOE) has concluded that the Bikini atoll is unsafe for resettlement. In response to the Bikinians' request for an independent review, we have examined the following DOE findings: (a) radionuclide contamination of Eneu and Bikini Islands, (b) radiation dosage to those who might resettle the islands, and (c) risks to the health of such settlers.

We are in practical agreement with the DOE estimates. Resettlement of either island in 1983 would lead to a range of annual or 30-year cumulative doses that exceed the Federal Radiation Council (FRC) guides for the general population, but not those for occupation exposure. By 2013 resettlement of Eneu probably would be permissible.

The principal source of radiation dose is local food, especially coconut, owing to contamination of the soil by cesium-137. A precise estimate of dose is impossible because an accurate projection of the diet is impossible. The availability of imported foods would lessen local food consumption, but not sufficiently to meet the FRC guides for the general population. The 30-year cumulative index dose is 61 (25-122) rem for Bikini, and about 8 (3-16) rem for Eneu.

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Richland, Washington 99352

Dear Dr. Bair:

This will confirm recent telephone conversations seeking your assistance in the review of the cleanup criteria for Enewetak that AEC/ERDA was responsible for preparing. The key element in plans for the ongoing Enewetak Atoll project is recommendations for cleanup and rehabilitation criteria developed by an AEC Task Group in June 1974, and decisions by Defense Nuclear Agency (DNA) on crater disposal of contaminated debris and soil on Runit Island. Several factors opt for a final review of these recommendations and decisions; namely, EPA has in draft for final review, "Guidance on Dose Limits for the Transuranium Elements in the General Environment"; Mahlon E. Gates, Manager, NV, has indicated his professional staff have voiced objections to the disposal plan and believe that "soil cleanup" of the northern islands according to AEC guidance is unsupportable, unsound, and counterproductive; concern has been expressed for the cleanup guidelines in a letter to Dr. Liverman which was prepared by a number of scientists at the time of the Livermore review of all AES Pacific activities on June 27-29, 1972; DOD has a heavy commitment to the cleanup of Enewetak Atoll and to a technique of disposal that has changed with time and will shortly begin to expend considerable effort in soil removal and disposal activities; and ERDA has commitments to provide certification of Enewetak cleanup and long term radiological followup of the Atoll when it is resettled.

You are invited to participate in a review of:

1. AEC recommendations for cleanup and rehabilitation of Enewetak Atoll and specifically the criteria for plutonium-239 in soil, and

2. Environmental and health implications and long term monitoring requirements for crater disposal of contaminated debris and soil on Runit Island.

AUG 1 1 1977

A copy of the AEC Task Group report is enclosed along with additional background material. You will be informed of arrangements for a review session, which is expected to be held next week at a location as yet undetermined. If there are any questions, please contact Bruce Wachholz on 353-4365 or FTS 233-4365.

Sincerely,

for James L. Liverman
Assistant Administrator
for Environment and Safety

Enclosure:
As stated

Identical Letters Sent To:

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Department of Energy
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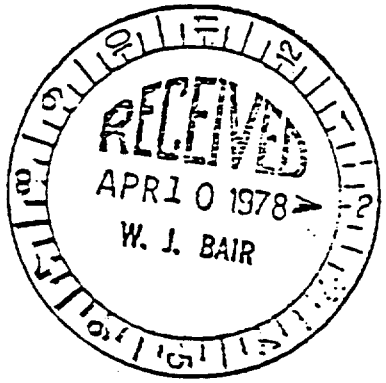
APR 4 1978



William J. Bair, PNL
William L. Templeton, PNL
Richard O. Gilbert, PNL
Chester R. Richmond, ORNL
John A. Auxier, ORNL
Chester W. Francis, ORNL
John W. Healy, LASL
Roger O. McClellan, Lovelace
Bruce W. Wachholz, DOE

The Department of Energy is providing radiological support to the Defense Nuclear Agency and Department of the Interior in the cleanup and rehabilitation of Enewetak Atoll. DOE is providing technical advice to these agencies and certain other services including radiological monitoring, a radiochemistry laboratory plus an instrument calibration and maintenance facility, and data processing and analysis. Also, DOE is to certify completion of cleanup on an island-by-island basis according to an agreement with Defense Nuclear Agency. Field services are being provided at Enewetak by the Nevada Operations Office and its contractors funded by OES. The cleanup project is expected to continue for about 2-1/2 to 3 years.

Pursuant to these activities, there is need for an overview of this project by a group of experts not directly engaged in the work, who will periodically evaluate these operations and advise the Director, Operational and Environmental Safety, (OES), and where applicable, the Assistant Secretary for Environment. OES anticipates a schedule that calls for a programmatic review of DOE Enewetak radiological support activities about every 6 months or more frequently if needed. An initial orientation visit to Enewetak will be made with later visits if needed.

This letter will confirm our telephone invitation for your participation in the Advisory Group on Cleanup of Enewetak Atoll. The first meeting is scheduled for April 13-14, 1978, at the Nevada Operations Office in the Main Conference Room, at 9 a.m. An agenda will be provided at a later time.

Enclosure I is a draft charter, subject to revision. Enclosure II is a preliminary draft report, "Assessment of Potential Doses to Populations From the Transuranic Radionuclides at Enewetak Atoll," for review. Another cleaned-up and corrected draft with additional information (numbers in Tables will not change) should be available before the April meeting.

The OES contact is Tom McCraw, FTS 233-3721. We greatly appreciate your willingness to participate in this Advisory Group.

Hal Hollister, Director
Division of Operational and
Environmental Safety

Enclosures:
As stated

cc w/encls: Roger Ray, NV
cc w/o encls: J. L. Liverman, ASEV

DRAFT

Enclosure I

Charter

Advisory Group on Cleanup of Enewetak Atoll

Objective: To secure a body of expert advice and judgments on DOE radiological support of cleanup and rehabilitation of Enewetak Atoll.

Approach: An Advisory Group of experts not directly related to the project is established and given responsibility for performing periodic reviews of DOE radiological support activities at Enewetak Atoll. This review will cover:

1. Cleanup criteria and recommendations.
2. Field operations:
   a. Monitoring and sampling
   b. Sample analysis
   c. Data handling and analysis including statistics
   d. Advisory activities in support of cleanup commander
   e. Application of cleanup criteria and recommendations
   f. Certification
   g. Post cleanup conditions including disposal of contaminated debris and soil
3. Dose estimates and applicable standards

The Advisory Group will report to the Director, Operational and Environmental Safety (OES), and where applicable, to the Assistant Secretary for Environment. The Group will observe DOE field operations at Enewetak, as needed, review progress reports and situation reports, participate in program reviews that are to be conducted every 6 months, review and evaluate certification actions and documentation, and will report findings and provide advice to OES. The Review Group's work will be completed when DOE concurrence is given that Enewetak Atoll cleanup is completed and DOE has discharged its advisory role to the Department of the Interior on rehabilitation of the Atoll.

bcc: JJ Fuquay
File/LB

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
Richland, Washington 99352
Telephone (509) 946-2421
Telex 32-6345

May 12, 1978

Mr. Hal Hollister
Director
Operational and Environmental
Safety
Office of the Assistant Secretary
for the Environment
Department of Energy
Washington, D.C. 20545

Dear Hal:

In response to your letter of April 4, 1978, I am pleased to accept membership on the Advisory Group for Cleanup of Enewetak. I also agree to serve as chairman, with the understanding that you should feel free to replace me at any time you believe the activities of the Advisory Group are not receiving adequate attention.

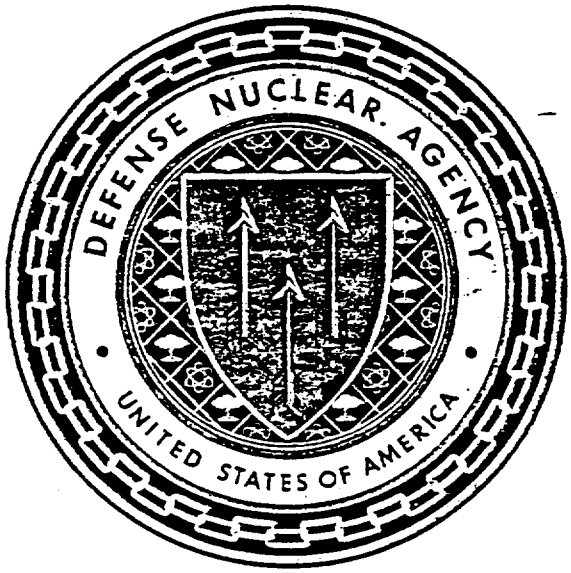
Sincerely yours,

Bill

William J. Bair, Ph.D.
Manager
Environment, Health, and
Safety Research Program

WJB:ms

THE RADIOLOGICAL CLEANUP OF ENEWETAK ATOLL



DEFENSE NUCLEAR AGENCY

which they considered technically unsupportable, economically unsound, and environmentally counterproductive. It recommended that the soil cleanup plans, which had been developed over the past 5 years and were even then being implemented, be reviewed again.[18]

THE BAIR COMMITTEE

As a result of the unsigned position paper, ERDA convened a panel of scientists at ERDA-NV on 15-17 August 1977 to review:

a. AEC recommendations for cleanup and rehabilitation of Enewetak and, specifically, the criteria for plutonium (Pu-239) in soil.
b. Environmental and health implications and long-term monitoring requirements for crater disposal of contaminated soil and debris on Runit.

The panel was chaired by Dr. W. J. Bair of Battelle-Pacific Northwest Laboratory and subsequently became known as the Bair Committee. It included scientists from several disciplines. Two of the members had attended the Marshall Island Workshop. Observers and guests included most of the ERSP management; DNA's Deputy Director for Operations, Major General William E. Shedd; BG Tate; and Colonel Charles J. Treat, USA, Field Command's Special Assistant for Enewetak Operations.[19]

Briefings were presented by ERDA representatives on that agency's participation in developing the soil cleanup guidelines and the policy decisions to which the unsigned position paper objected. DNA also presented briefings on the implementation of the AEC guidelines in the Environmental Impact Statement (EIS).[20] During the course of these briefings, several critical issues surfaced.

THE CRITERIA ISSUE

The AEC Task Group had recommended 400 pCi/g as a cleanup criterion because it had been shown, conservatively, to be equivalent to the maximum permissible concentration (MPC) in air for radiologically unrestricted areas.[21] Accordingly, a nonoccupationally exposed individual could remain continuously in such concentrations and not exceed the permissible radiation dose rate limits: 1.5 rem/yr to lung or 3 rem/yr to bone. As is frequently done, the AEC Task Group introduced a factor of ten safety margin and recommended 40 pCi/g as a criterion below which no cleanup was required. The Task Group recommended a factor of two only (safety margin) and dose limits for whole body.[22] The corresponding dose at 40 pCi/g thus would be 10 percent of that permitted for an

questions on the compatibility of this guidance with that in the EIS. The association of criteria levels with island use was a surprising development to Field Command planners who had followed development of the criteria as a sampling technique to be used with the in situ system. The association between 100 pCi/g and agricultural use appeared to have no technical basis since the AEC Task Group Report treated islands to be used for food-gathering and agriculture the same with respect to plutonium.

Dr. Bruce Wachholz, ERDA Headquarters, briefed the panel on unofficial EPA views related to the conformance of the soil cleanup criteria to its forthcoming guidance, then under development, on dose limits for transuranic elements in the general environment. EPA's verbal assessment was that the "less than 40 pCi/g" level would not be a problem and the "40-400 pCi/g" range most likely would not be a problem. During the guidance development, a very preliminary EPA document, "Draft Proposal, Federal Guidance for Plutonium in Soils, 19 August 1976," attracted particular DNA interest [23,24,25] as it indicated a cleanup action level about a factor of three lower than the 40 pCi/g level recommended by the AEC as a very conservative guideline for the Enewetak Cleanup.[26] Guidance of this nature, if followed, would significantly affect quantities of soil for removal; however, informal opinions from EPA and DNA indicated that no guidance for the United States should apply to Enewetak Atoll. MG Shedd stated DNA's view that the cleanup should proceed as planned. Mobilization was too far advanced to allow the project to be delayed for more studies, reviews, and EIS actions to consider undefined alternatives of uncertain value.

The Bair Committee generally rejected the unsigned position paper's objections and endorsed the OPLAN 600-77 soil cleanup criteria, removal, and disposal methods. There was unanimous agreement that the criteria for contaminated soil cleanup were reasonable and that the planned emplacement of plutonium-contaminated soil and debris in concrete in Cactus Crater did not impose unacceptable environmental and health risks. The panel recommended that more specific guidance for application of the criteria to plutonium levels between 40 and 400 pCi/g be developed for the Commander Joint Task Group (CJTG).[27] Although the unsigned position paper had been thoroughly addressed and answered, its resolution set in motion events which consumed a significant amount of the project's most critical resource—time—and substantially delayed soil cleanup operations. These events are described in subsequent sections.

THE PRIORITY ISSUE

In its report on the August 1977 conference, the Bair Committee expressed concern that the cleanup project could be terminated before completion if funds and other resources appropriated for the effort proved insufficient due to underestimates of the amount of soil that had to be removed.[28] This concern was shared by BG Tate and COL Treat, who made their first visit to the atoll shortly after the conference adjourned.

The EIS identified four islands requiring cleanup of plutonium concentrations over 400 pCi/g: Boken, Lujor, Aomon, and Runit. Eight others in the 40 to 400 pCi/g range were listed for consideration on a case-by-case basis: Bokoluo (Alice), Bokombako (Belle), Kirunu (Clara), Louj (Daisy), Mijikadrek (Kate), Kidrinen (Lucy), Aej (Olive), and Eleleron (Ruby). To these, the CONPLAN and OPLAN added Enjebi for consideration on a case-by-case basis. When BG Tate arrived, work was beginning on Enjebi in accordance with the initial strategy, with a view toward continuing its cleanup to qualify it for eventual residential use. Since Enjebi was not identified for cleanup under Case 3 of the EIS and it could require 6 months or longer to accomplish the cleanup, there was considerable opposition to going ahead with this effort. CONPLAN 1-76 estimates indicated that over 27,750 man-hours would be required to remove debris from the island and over 24,000 man-hours would be required to remove the plutonium-contaminated soil concentrations to levels below 40 pCi/g[29]. BG Tate was unwilling to devote so many man-hours to Enjebi without more assurance that resources would be available to complete the items specifically required in the EIS. He was particularly concerned about Runit, where 58 percent of the radiological cleanup work identified in Case 3 of the EIS would be required. Therefore, during his visit, BG Tate and Mr. Ray, the ERSP Manager, agreed to move out on identifying the work to remove plutonium from the burial crypts on Aomon, identifying the Lujor soil removal requirement, and characterizing the nature and scope of work to clean Runit to required levels.[30]

After BG Tate's visit, Mr. Ray, in a letter to Field Command, expressed surprise that the cleanup of Runit was considered so important. He asked what level of confidence Field Command expected in the Runit characterization the ERSP was being tasked to carry out and what priority it should receive. He indicated that ERDA-NV could identify the work required to clean Runit or could assist in preparing a reclama to leave Runit uncleaned and quarantined. He hinted that additional funding from DNA might be required for detailed Runit soil characterization.[31] BG Tate replied that he did not consider the reclama proposal to be a viable option and that the radiological survey of Runit should meet the same standards

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intakes of strontium and cesium, both of which were known to exist on Enjebi.[78]

BAIR COMMITTEE RECOMMENDATIONS

At the 6 January 1978 conference, Mr. Tommy McCraw, DOE, had indicated that Lawrence Livermore Laboratory (LLL) was being tasked to make an Enewetak dose assessment study which could serve as a basis for associating island use with concentration of plutonium and other transuranic elements.[79] On 3 April 1978, DNA was briefed on the key finding of the study. Based on an assumption that the dri-Enewetak would apportion their time on residence, agricultural, and food-gathering islands according to 60, 20, and 5 percent, respectively, compliance with the EPA guideline would be achieved if residence, agriculture, and food-gathering islands were cleaned to at least 10, 20, 40 pCi/g, respectively.[80,81] (The remaining 15 percent of the time was considered to be spent on the water, traveling or fishing, or away from the atoll; i.e., Ujelang, Majuro.) This finding caused concern at DNA since the stringent criteria might prohibit some islands from qualifying for their planned use as detailed in the EIS, and the required cleanup effort would be greatly expanded.

On 4 April 1978, DOE requested that the Bair Committee provide advice on the soil cleanup questions raised at the 6 January 1978 conference and on other radiological support matters.[82] The Committee, also referred to as the Enewetak Advisory Group, met with DOE and DNA representatives at DOE-NV on 13-14 April 1978 and was briefed on the status of the cleanup and its current problems. A key topic of discussion was the recent LLL draft dose estimate study. The principal technical point of the study related to the unexpected large dose predictions to bone resulting from inhalation of all transuranics, compared to those from plutonium alone. The study indicated that inhalation dose to bone might exceed the dose to lung by a factor of three or more (the ratio of dose limits for lung and bone). The large dose was due to the less abundant Am-241 which Dr. William Robison of LLL explained was the result of his using a high Am-241 "gut transfer coefficient." The high coefficient was challenged by some Committee members, but Dr. Robison stated that he felt obligated to use the high coefficient since it had been noted recently by several experimenters. This draft dose estimate study caused Am-241 to be considered an important contributor to dose and an important ingredient in cleanup evaluations.

The Bair Committee met again on 26-27 April 1978 in Denver, Colorado, to consider the following questions:

a. Is it possible to develop dose-related cleanup guidance that would

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significantly exceed p
b. What advice can be
facilitate planning fo
c. What additional infc
the confidence of
transuranics?
d. Can plowing be used
in soils?

The Committee revie
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assure that doses to future residents of Enewetak Atoll would not significantly exceed proposed EPA guidelines for transuranics?

b. What advice can be given to DNA at its early May conference to facilitate planning for cleanup of transuranics on Enewetak?
c. What additional information can be obtained which could improve the confidence of the dose estimates and cleanup criteria for transuranics?
d. Can plowing be used as an effective cleanup measure for transuranics in soils?

The Committee reviewed information and data provided by DOE-Division of Occupational and Environmental Safety, LLL, DOE-NV, and DNA. The draft LLL dose assessment study was the basic document from which the Committee was to formulate answers to the questions raised and to provide advice. The Committee offered the following response to the questions as they pertained to transuranic elements only (not fission products, which they understood might delay the resettlement of some islands for a number of years):

a. The Bair Committee did not find it possible to develop reasonable cleanup guidance which would assure that radiation doses from transuranics to future residents would not exceed proposed EPA guidelines to the extent to be of concern. Obviously, the more stringent the cleanup criteria, the greater the degree of assurance; but uncertainties inherent in our present understanding of the problem precluded absolute assurance. One could not predict with certainty the contamination levels that would exist in the islands after cleanup; this would be determined at a future time. One could not predict the lifestyle and dietary habits of every individual who returns to the islands. Perhaps most important, many of the factors that are involved in movement of transuranics in the environment and the depositions and retention of transuranics in human beings are not well established.

However, the Committee was of the opinion that its recommended cleanup criteria would result in average transuranic radiation doses to subsequently exposed populations that would be commensurate with proposed EPA guidelines. The EPA considered its guidance levels to be equivalent to a lifetime risk of about 14 premature cancer deaths per 100,000 persons exposed and to perhaps an equal number of genetic effects, although these estimates are based on many uncertain assumptions and generally are considered to be quite conservative. An estimate of 14 cancers per 100,000 people would correspond to a 3 percent chance of one cancer appearing in a population of 200 people exposed to EPA guidance levels for their lifetime; or expressed differently, to a probability of one cancer in every 2,100 years (assuming a constant population size).

b. Considering the physical and ecological limitations to removal of transuranics from the Enewetak Atoll, the Bair Committee recommended the following cleanup criteria:
   (1) All one-quarter or one-half hectare areas on residential islands should be cleaned unless the average concentration in surface (0-3 cm) soil does not exceed 40 pCi/g (with 70 percent confidence). That is, each one-quarter or one-half hectare area should be cleaned if the average concentration plus one-half standard deviation (for the unit area) exceeds 40 pCi/g. From the information then available and being used for dose assessment, the Committee believed this procedure would provide a reasonable expectation that dose in the bone and lung would be commensurate with the EPA guidance. In terms of radiation dose-sparing benefit to future inhabitants, the Committee pointed out that cleanup of a standard area on a residential island was worth about four times as much as cleanup to a given level on an agricultural island and 12 times as much as cleanup of the same area to the same level on an island designated for food gathering. In the light of existing contamination levels and available cleanup resources, it would appear that cleanup of all one-quarter or one-half hectare areas on residential islands according to the above criteria should receive first priority.
   (2) Because the other islands may have increased use over that currently assumed, a second priority should be the cleanup of agricultural island half-hectare areas unless the average concentration for the unit does not exceed 80 pCi/g (with 70 percent confidence).
   (3) A third priority should be the cleanup of food-gathering island half-hectare areas unless the average concentration for the unit does not exceed 160 pCi/g (with 70 percent confidence). If resources were exhausted, some islands might not be cleaned up, and final dose assessment might indicate that these islands would have to be quarantined.

The Committee noted that the soil profile on Lujor was anomalous, since the concentration of transuranics appeared to be uniform with depth. They believed that the possibility of effective cleanup for use as a residential or agriculture island was remote. However, the possibility of covering Lujor with the less contaminated soil from the residential islands, and perhaps from the agricultural islands, should be considered for lowering the average surface contamination levels and reducing the logistics problems of transporting the soil from the other islands to Runit

Soil Cleanup Planning

The Committee listed s
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The Committee listed several ongoing and proposed actions to provide additional information which could improve the confidence of the dose estimates and cleanup criteria for transuranics. They also indicated that plowing might reduce surface soil concentrations and hence reduce the potential inhalation problem, but that it was unlikely to reduce plant uptake.[83]

DOE SOIL CHARACTERIZATION

The DOE-ERSP characterization data for the northern islands was forwarded to Field Command on 27 April 1978. It covered all transuranics, while the EIS covered plutonium only, and it included estimates of soil volumes to be excised under various conditions. Some of these estimates were used in updating the Field Command time and motion study for the briefing to be given at the 3-4 May 1978 conference, while others were disregarded due to significant variances with data on hand.

The DOE characterization had taken 9 months to complete. In general, it confirmed what had been indicated in the 1972 radiological survey, AEC Task Group recommendations, EIS, CONPLAN, and OPLAN. Five islands required removal of plutonium concentrations to permit their use as planned by the dri-Enewetak: Aomon, Boken, Enjebi, Lujor, and Runit. None of the eight case-by-case islands required any soil cleanup. Nine other northern islands, not previously identified for soil cleanup, also had been characterized and found with no contamination above 40 pCi/g.

DOE-ERSP's estimates of the volumes of soil to be removed from the four islands named in the EIS to permit the planned use was approximately 72,000 cubic yards. The EIS estimate for those islands was 79,000 cubic yards. The DOE-ERSP estimate for the fifth island, Enjebi, was 44,835 cubic yards to qualify it for residential use.[84] These estimates were reassuring to the planners since they indicated that volumes of soil previously estimated to be moved would not be materially affected by the inclusion of all transuranics, which had not been previously considered.

Regarding the time utilized for the soil characterization, it should be noted that the advanced techniques developed by DOE-NV for this complex task and the new equipment fabricated from research and development components were truly remarkable. To field this effort in the distant, harsh Enewetak environment—and to put it on a paying basis relatively quickly—was quite an achievement. The soil cleanup project had been delayed, but this had been compensated for by a speedup in contaminated debris cleanup. Since DNA had avoided making decisions involving major resource commitments which might have proven to be ill-advised, no serious harm had been done to the overall project by the delay.

arithmetic error and the concern was unfounded.) The new LLL dose assessment was reviewed by the Bair Committee and was the basis for their recommendations of revised levels for agricultural and visitation/food-gathering islands.[94] The arithmetic error was not discovered until after the new guidelines were issued. The new guidelines were based on estimated doses from time spent in various activities, such as food gathering or residence, on various islands with different levels of contamination (Figure 6-15).

The model for the LLL dose assessment and Bair Committee recommendations assumed that the people spent 60 percent of their time on residential islands, 20 percent on agriculture islands, and 5 percent on food-gathering islands. It also assumed that 65 percent of the coconuts and all of the other food consumed would be grown on residence islands. An estimated 25 percent of the coconuts consumed would come from agriculture islands and 10 percent from food-gathering islands.

The cleanup guidelines proposed removal of concentrations exceeding 40, 80, or 160 pCi/g as appropriate. The resultant island averages, however, would be lower. Dose calculations based on these guidelines were estimated at 10.3 millirad per year from inhalation and 2.7 millirad per year from terrestrial sources for a total of 13 millirad per year to the bone. This exceeded the proposed EPA guideline of 3 millirad per year; however, it was well within the International Commission on Radiological Protection dose limit to bone which was equivalent to 30 millirad per year.

COMMITTEE RECOMMENDATIONS*
TRANSURANIUM ELEMENTS IN SOIL

PRIORITY**	ISLAND TYPE	SOIL CONCENTRATION***	AREA
I	VILLAGE ISLANDS	≤ 40 pCi/g	1/4 HECTARE
II	AGRICULTURAL ISLANDS	≤ 80 pCi/g	1/2 HECTARE
III	PICNIC ISLANDS	≤ 160 pCi/g	1/2 HECTARE

* HEAVILY QUALIFIED DUE TO UNCERTAINTIES. NO ABSOLUTE ASSURANCE CAN BE GIVEN—IN THE OPINION OF THE ADVISORY GROUP, CLEANUP TO THESE LEVELS WILL RESULT IN AVERAGE TRANSURANIC DOSES COMMENSURATE WITH PROPOSED EPA GUIDELINES.

** IF RESOURCES ARE EXHAUSTED, SOME ISLANDS MAY NOT BE CLEANED UP; FINAL DOSE ASSESSMENT MAY INDICATE THAT THESE ISLANDS WILL HAVE TO BE PERMANENTLY QUARANTINED.

*** WITH 70 PERCENT CONFIDENCE.

FIGURE 6-15. DOE DOSE.

could be transported by trucks loaded on the watercraft in a year's time. Use of bulk-haul technique on two of the LCUs and three LCM-8s would increase the estimated capacity to 77,000 cubic yards.

For the purposes of discussions, the soil transport estimate was rounded to 80,000 cubic yards. This transportation limit became confused by some planners with the EIS estimate of 79,000 cubic yards of soil over 40 pCi/g to be excised from Aomon, Boken, Lujor, and Runit. It also became confused with the maximum capacity of the Cactus Crater container. These misunderstandings were significant because, like the Treat factor, they led to miscalculations of the workload and apparent constraints in soil cleanup planning. The only real constraints on completing the removal and containment of all the contaminated soil were time, based on the scheduled 15 April 1980 completion date, and the capacity of boats to move soil within that time constraint.

The new soil volume estimates, coupled with these constraints, posed serious problems. Attempting to clean Enjebi to residential standards would eliminate any other soil cleanup except Runit, and even then there was no assurance that Enjebi could be completed. If this were done, Aomon, Boken, and Lujor would have to be left with levels over 400 pCi/g and possibly quarantined. On the other hand, cleanup of the other islands would apparently eliminate Enjebi as a future residence island. Also, leaving Runit until last raised the possibility that it might not be cleaned to prescribed standards.

The final briefing evolved into a lengthy discussion of alternatives and combinations of options for soil cleanup. Mr. Mitchell, of MLSC, reiterated the position he and the people had taken and maintained from the beginning: every attempt should be made to make every bit of the atoll available to all of the people of Enewetak for any use that they might see fit. Mr. DeBrum, District Administrator of the Marshalls District, affirmed that the TTPI supported the people's position to have all the islands as clean as possible within the available resources.[103] The conferees then reviewed and discussed each issue on which a decision was required; and the Director, DNA, after hearing all recommendations, made the necessary decisions to advance the cleanup project. The critical decisions are outlined in the following nine sections.

CONTAMINATED SOIL CRITERIA DECISION

The first issue considered was the criteria for contaminated soil removal. The criteria recommended by the Bair Committee for nonresidential islands were considerably more stringent than the AEC Task Group guidelines and the guidance furnished by ERDA for the OPLAN.

Under the Bair criteria, infrequent visits to gathe should not exceed 160 pC (0-3 centimeters) average Condition A would be lo

Agriculture islands, to coconuts, pandanus, an concentration of transur hectare. On this basis, O pCi/g to 80 pCi/g.

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Since the Bair Commi agency responsible for project, the Director, DN pointed out that, while henceforth be regarded a accomplishing the most b

DOE representatives st the entire problem; that soil cleanup data and the to which this conferenc Committee was proposin to pin down the islands Manager for cleanup.

The Director, DNA dilemma faced in the clea criterion for food-gatheri 400 pCi/g. Cleanup of tw as food-gathering and approximately half of th resources from, perhaps did not do this, the two might be unacceptable fo

Mr. Roger Ray, DOE- into believing that an automatically have to be Bair Committee criteria and that the Committee made to comply with th resources. After that wa islands where work coul

Under the Bair criteria, islands designated for food gathering (used for infrequent visits to gather food such as coconut crabs, birds, and eggs) should not exceed 160 pCi/g concentration of transuranics on the surface (0-3 centimeters) averaged over one-half hectare. On this basis, OPLAN Condition A would be lowered from 400 pCi/g to 160 pCi/g.

Agriculture islands, to be used principally for commercial crops of coconuts, pandanus, and breadfruit, should not exceed 80 pCi/g concentration of transuranics on the surface averaged over one-half hectare. On this basis, OPLAN Condition B would be lowered from 100 pCi/g to 80 pCi/g.

Residential island criteria remained unchanged; i.e., surface concentration of transuranics, averaged over one-quarter hectare, should not exceed 40 pCi/g. This coincided with OPLAN Condition C.

Since the Bair Committee criteria had been endorsed by DOE, the agency responsible for furnishing radiological advice for the cleanup project, the Director, DNA believed DOD must accept them. However, he pointed out that, while the 40-80-160 pCi/g cleanup criteria would henceforth be regarded as policy, their rigid acceptance must not preclude accomplishing the most beneficial cleanup with resources available.

DOE representatives stated that the Bair Committee had not been given the entire problem; that is, the Committee did not have access to all the soil cleanup data and the engineering soil removal and movement factors to which this conference had been exposed. Therefore, although the Committee was proposing priorities for cleanup, it was not actually trying to pin down the islands that should be selected by the DOD Project Manager for cleanup.

The Director, DNA then stated that he was concerned about the dilemma faced in the cleanup if he unequivocally agreed to 160 pCi/g as the criterion for food-gathering islands, as opposed to the originally specified 400 pCi/g. Cleanup of two islands, Boken and Lujor, desired by the people as food-gathering and agricultural islands respectively, would utilize approximately half of the soil transport available, thus diverting these resources from, perhaps, a more beneficial application. He felt that if he did not do this, the two islands might have to be quarantined, and this might be unacceptable for political and humanitarian reasons.

Mr. Roger Ray, DOE-NV, stated that it was important not to get trapped into believing that an island which did not meet 160 pCi/g would automatically have to be quarantined. He expressed the opinion that the Bair Committee criteria should not be accepted in a literal interpretation and that the Committee would expect that sensible trade-offs would be made to comply with these criteria as closely as possible within available resources. After that was done, some restrictions might be required on islands where work could not be completed.

The Director, DNA requested that DOE examine the possibility of not cleaning Boken and Lujor to 160 pCi/g and identifying patterns of living that could be adopted for those islands other than quarantine. DOE representatives agreed to have this done.

Dr. W. P. Wood, of EPA's Radiation Programs and its representative at the conference, pointed out that DOE/DOD acceptance of the 40-80-160 pCi/g criteria should not imply EPA approval and that, once the plan for soil removal was established, EPA would desire to examine that plan. The Director, DNA stated that he understood that there was no EPA blessing, but he also pointed out that Enewetak really did not come under the draft EPA guidelines.

The Director, DNA decided to accept the criteria recommended by the Bair Committee and DOE as the standards for contaminated soil cleanup. This acceptance was contingent upon the Bair Committee and DOE developing more precisely the status of islands (e.g., Boken or Lujor) which might end up being cleaned to below 400 pCi/g, but not down to the 160 pCi/g criteria recommended by the Bair Committee for food-gathering islands.[104]

The criterion for subsurface contamination was not discussed at the conference. That criterion, OPLAN Condition D, was the most stringent and difficult to achieve. Subsurface concentrations of transuranics were not to exceed 160 pCi/g averaged over one-sixteenth hectare on any island to be used by the dri-Enewetak.

NORTHERN ISLAND RESIDENCE DECISION

The issue of possible residence on one or more of the northern islands was raised during the discussion on soil cleanup criteria because the new criteria were based on a dose assessment model which assumed soil contamination levels that would occur only in the northern islands. The dose assessment indicated that living on islands having surface transuranic levels which averaged 40 pCi/g, growing crops on islands which averaged 80 pCi/g, and visiting islands which averaged 160 pCi/g could result in a dose of about 13 millirads for transuranics alone, over four times the proposed new EPA guideline of 3 millirads per year for the U.S. Doses from strontium and cesium in the drinking water, coconuts, and other local food were not considered since it was assumed that no one would be permitted to live on Enjebi until after those elements decayed to acceptable levels.

By this time, everyone was aware of the Bikini cleanup and resettlement problems. Mr. McCraw, of DOE, stated that Bikini was typical of what could happen in the Marshall Islands. Bikini had suffered a drought and

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ISLAND PRIORITY DECISION

The next issue was to decide which islands would be cleaned and to what levels in order to provide the most effective use of resources to the greatest benefit of the people. As in previous discussions, the critical considerations centered on accomplishing a full Case 3 cleanup or cleaning Enjebi to residential status and leaving undone some of the original tasks such as the reduction of concentration on Lujor or Runit.[110]

During the conference deliberation of this issue, the relative merits of the AEC Task Group recommendations, the EIS mission statement, and the Bair Committee recommendations were discussed at length. One dominant position, which was supported by Field Command, was that the AEC Task Group recommendations and EIS Case 3 cleanup were intended to clean up the worst hazards first, the bits of plutonium and concentrations over 400 pCi/g on Runit, Aomon, Boken, and Lujor, to insure that people would not be exposed to them during the thousands of years after the cleanup was completed. The proponents of this position were skeptical that, should any of these islands not be cleaned to prescribed levels, the people would abide by any quarantine placed or remaining in effect indefinitely.

The dominant counterposition was that the resources should be used to clean Enjebi to provide more residential land for a growing population and to restore the traditional home island of the dri-Enjebi. Proponents of this position, which included some Field Command staff members, considered some of the EIS mission, such as the cleanup of Runit, to be peripheral and not the best use of resources. They urged that an attempt be made to clean Enjebi to as near residential level as possible on the assumption that the 40 pCi/g criteria need not be absolute or that plowing might prove effective and acceptable.[111] This position had its foundation in the fact that the Bair Committee recommendations were based on 6 years' additional information and understanding of the problems considered by the AEC Task Group and that the cleanup effort and money should be spent to permit more beneficial use of the islands by the people. With the information now known about Runit contamination levels and the subsurface "marble cake" effect there, coupled with the fact that the allowed upper level criteria had been changed by the Bair Committee, it no longer appeared to make good sense to spend a great effort on Runit with the possibility of never reaching levels which would make that island usable for any purpose.

The choice between these two principal alternatives raised the question of which would have more beneficial results: cleaning a residence island which possibly could not be used until strontium and cesium levels in its soil and water dropped; or cleaning of Lujor, Boken. and—to a degree—

FIGURE 7-1. LCM-8 MODIFICATIONS.

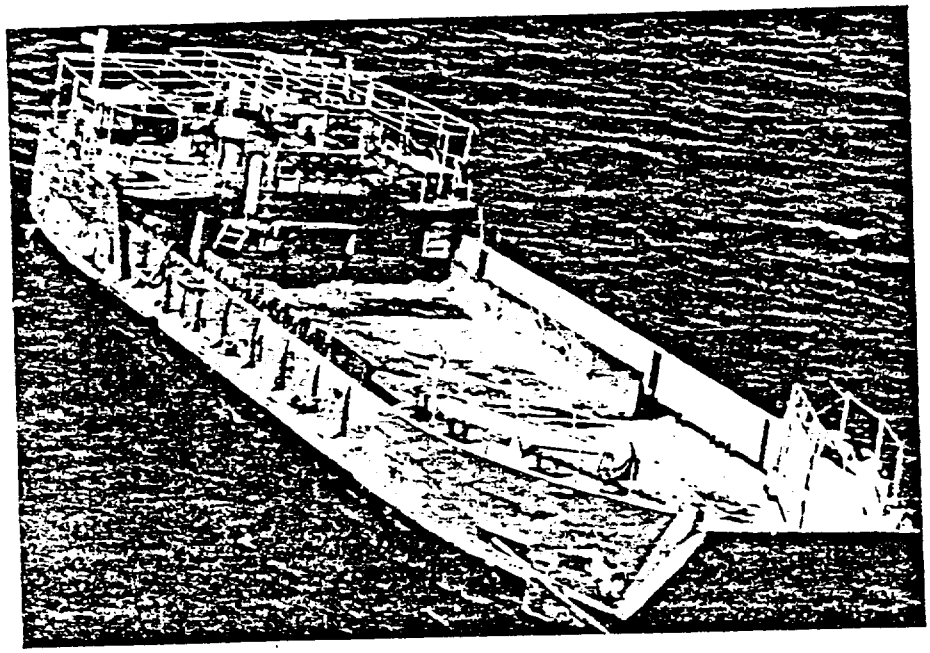

FIGURE 7-2. LCU MODIFICATIONS.

In August 1978, the Bair Committee visited the atoll and was asked for guidance on several matters, including the stringency of the 40-80-160 pCi/g criteria for residential, agricultural, and food-gathering islands. The Bair Committee responded that every effort must be expended to reach these levels and that only after it is clearly shown that these levels cannot be reached should a reconsideration be made.[13,14]

DOE-ERSP extracted soil samples from the Easy and X-Ray GZ areas on northwest Enjebi (Figure 7-8). Some 740 samples were taken from the sidewalls of trenches dug by backhoes to a depth of 120 centimeters (4 feet). On 30 September 1978, DOE-ERSP reported that the two areas had subsurface transuranics greater than 160 pCi/g, thereby exceeding Field Command's Operations Plan (OPLAN) Condition D. It was estimated that 1,300 cubic yards of soil would have to be removed to a depth of approximately 100 centimeters (3.3 feet).[15]

ENJEBI SOIL REMOVAL CONTINUES

On 3-6 October 1978, the Deputy Director, DNA, Major General Richard N. Cody, USAF, reviewed Enjebi soil cleanup operations at the atoll and decided to continue cleanup to 40 pCi/g surface levels. Approximately 12,621 cubic yards of soil above 45 pCi/g were removed between 24 August and 21 October 1978.

A fine grid (25 meters) IMP survey in early November 1978 revealed new areas requiring excision, even though 50-meter grid IMP data and statistical analysis had indicated, with 70 percent confidence, that such excision would not be required. This increase amounted to approximately 5,200 cubic yards. In addition, 29 areas over 40 pCi/g were identified. Soil removal operations continued with another 17,694 cubic yards of soil being removed from these locations to reduce surface contamination from 45 to 40 pCi/g. In addition, 2,600 cubic yards were removed from subsurface areas to bring them to less than 160 pCi/g. A total of 52,187 cubic yards of soil had been removed from the island when the Enjebi cleanup forces were redeployed on 21 April 1979, having completed all but the LLL tree farm and plowing experiment (Plow-X) areas.[16,17,18]

A week later, DOE-ERSP notified the CJTG that the Plow-X area could be cleaned. Soil cleanup in the Plow-X area was completed on 9 May 1979, resulting in the removal of another 820 cubic yards. This completed the Enjebi soil cleanup operation. Photographs of Enjebi before and after cleanup operations are at Figures 7-12, and 7-13. The final DOE-ERSP certificate indicated that, based on one-quarter hectare averaging, 97 percent of the island was less than 40 pCi/g (surface condition). A few areas, well distributed over the island, exceeded 40 pCi/g, but none

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free of ferric interference. The effects of the causeway's steel support members and retaining wall were found to be minimal beyond about 10 meters. The actual measurements of field intensity were made on the existing grid with at least three samples taken at each node to minimize erroneous readings. At each point, a number from one to ten was assigned (the higher the number, the greater the probability of ferrous metal).

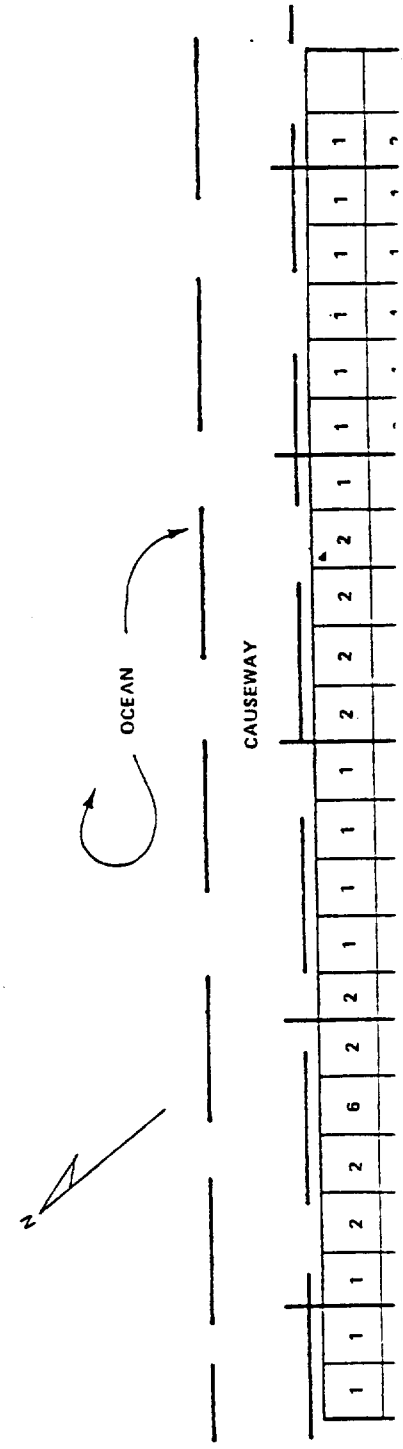
The results of this survey are shown at Figure 7-29. As was expressed by U.S. Oceanography, the magnetometer can be used to give very rough estimates of ferric material present. Notwithstanding this uncertainty, the use of the magnetometer survey data in combination with other survey results greatly assisted in the overall project.

DEEP-DRILL SAMPLING

Deep-drill sampling was conducted by personnel from the U.S. Army Engineer District, Mobile, Alabama, from 26 November 1978 to 14 January 1979 (Figure 7-30). The primary purpose was to locate the areas of soil contamination in the crypt area. To achieve this objective, soil samples were extracted at the nodes of the preestablished 5-by-5-meter grid at depth intervals of 2 feet. Drilling proceeded until the drill bit struck either the base coral reef or metal. This data, when combined with the magnetometer survey, gave a better approximation of the location of buried debris. The samples gathered were field screened using the IMP and analyzed through chemical analysis at the radiological laboratory on Enewetak Island. Horizontal locations of the contaminated soil above 400 pCi/g (disregarding depth) (Figure 7-31) and the estimates of debris locations from drilling (Figure 7-32) were used in conjunction with the magnetometer survey for further exploratory activities and designation of the sheet pile containment area.

AOMON CRYPT CLEANUP CONCEPTS

The objective of the Aomon Crypt Project was to remove all debris and subsurface contaminated soil above 400 pCi/g. The Bair Committee had determined that the Aomon Crypt was a special case; the 160 pCi/g criteria for subsurface contamination should not apply. As a result of the exploratory efforts, it was concluded that a sheet pile enclosure would be required for excavation of the heavily contaminated soil and debris around the center (node 45NE25) of the 5-by-5-meter grid system (Figure 7-33). With two exceptions, no other soil contamination was found above 400



as occur in nuclear explosions. The AEC Task Group had recommended a lifestyle for Enewetak which would limit residence to southern islands but would permit coconut agriculture in the northeast.[52] Utilizing NVO-140 data and methodology, the estimated doses to individuals would be no more than 30 percent of the AEC's recommendations.[53] The methodology used by Dr. Bramlitt differed in several respects from the methodology used in the previous estimates.

First, the Bramlitt estimates considered that each Enewetak person would obtain subsistence coconuts from specific northeast islands, rather than from the entire group of northeast islands. Thus, those persons having agriculture rights limited to a more highly contaminated northeast island were predicted to receive a higher dose than if some of their coconuts came from the lowercontaminated islands. Second, the Bramlitt estimates assumed coconut consumption to be much greater than previously estimated. The increase in consumption was based upon statements from individuals living at Ujelang, and it made allowances for other pathways involving coconuts for which there were no radiological data; e.g., fermented coconut sap, skin lotions, cooking oils, and meat consumed from animals raised on coconuts. Additionally, the recently discovered higher radiation levels among the people of Bikini Atoll were attributed to larger amounts of coconut in their diet than had been previously estimated.[54] Third, the Bramlitt estimates used Bikini data made available after publication of NVO-140. The Bikini data predicted greater uptake of radionuclides by coconuts.

Dr. Bramlitt's draft study recommended: (1) evaluating the impact of not planting coconuts on northeast islands; (2) collecting additional data on fission products at Enewetak while support forces were available; (3) reevaluating the diet assumed for the dri-Enewetak after cleanup; and (4) reassessing the dose for the postcleanup use of Enewetak Atoll.

The Director, DNA was briefed on the dose estimate study on 21 July 1978. The draft study then was distributed on 27 July 1978 to DOE (Headquarters and NV), members of the Enewetak Advisory Group (Bair Committee), and the Armed Forces Radiobiological Research Institute with a request for expeditious review, since the study indicated that changes might be desirable in the cleanup or rehabilitation programs then underway.

Based in part on the new data from measurements of the Bikini people and the recent experience of having to relocate them from Bikini Atoll, DOE recommended to DOI that coconut trees not be planted on the northern islands of Enewetak Atoll. It is possible that Dr. Bramlitt's dose estimate, raising much the same type of question, reinforced the DOE staff thinking. While this staff view had little effect on the DOD cleanup effort, it had the potential to exert a significant effect on the DOI rehabilitation

Another large volume of soil was bulldozed onto the reef in 1958 to provide a site for the Cactus event of Operation Hardtack I. The Cactus shot left a crater approximately 37 feet deep and 346 feet in diameter (Figure 8-2).

The northern half of Runit was significantly contaminated; however, only one shot, Erie, was detonated on the southern part of the island. South Runit—the area south of Station 1310, a large bunker in the center of the island (Figure 8-3)—was used primarily as a base camp, with an airstrip, boat landings, and other support facilities. By the time cleanup began, vines and grass covered most of the island, bordered by heavy brush (See Figure 8-4).[3] In the absence of human activity, Runit had become the roosting and nesting ground for one of the largest tern colonies on the atoll, numbering thousands of birds.

There were two reported burial sites on Runit: one near Station 1310 where a jar of plutonium-contaminated sand was buried, and the other a small, fenced area where another jar of contaminated sand, a box of contaminated material, and two small discs were believed to be buried. Other hazardous items on Runit included several bunkers, nine derelict landing craft which had been beached for shore protection (Figure 8-5), contaminated concrete blocks and slabs, wooden towers, and large quantities of contaminated metal scrap. An estimated 4,064 cubic yards of contaminated debris were to be removed from Runit, 56 percent of all the contaminated debris identified in the Environmental Impact Statement (EIS). An additional 6,155 cubic yards of noncontaminated debris were identified for removal in the EIS.[4]

Runit was one of four islands identified in the EIS (Vol. I, Table 5-4) for cleanup of plutonium concentrations over 400 pico curies per gram (pCi/g). It was estimated that there were less than 1,500 cubic yards of soil on the surface with such concentrations.[5] The EIS estimate of soil volumes to be removed to reduce the concentrations on Runit to less than 40 pCi/g was 63,725 cubic yards. This was in general agreement with the Department of Energy-Enewetak Radiological Support Project (DOE-ERSP) estimates in April 1978.[6] The desired use of Runit by the dri-Enewetak, in the first edition of the Master Plan, was for agriculture, to restore the large groves of coconuts it had once borne. Levels of strontium and cesium, the principal radiological constraints on agriculture throughout the atoll, were considerably lower on Runit than on Enjebi or other northern islands proposed for agriculture. It was estimated that 20,000 cubic yards of soil would have to be removed to bring Runit to below 80 pCi/g, the Bair Committee guideline for agriculture, or 14,500 cubic yards to reduce concentrations below 160 pCi/g and qualify Runit for visitation and food-gathering use.[7] The material was to be placed in the craters where it would not be readily available to man and where it could